Rattus exulans in Western Samoa

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THE COMMON RAT of Polynesia is *Rattus exulans* (Peale). It appears to be closely related to, and probably derived from *Rattus concolor* of the Malay region. The concolor group, and its derivatives, occur all over the Pacific, being represented in the Oceanic islands by *R. exulans*, *R. micronesiensis* and *R. hawaiiensis*. Other species have been erected for the Polynesian forms, but it may be simpler to regard these as synonymical with *R. exulans* at least until larger series have been collected. Tate (1935) lists as synonyms of *R. exulans* (Peale):

Mus exulans Peal 1848: Tahiti

Mus vitiensis Peale 1848: Fiji

Mus maorium Hutton (1878) 1879: New Zealand

Mus jessook Jentink 1879: New Hebrides

Mus huegli Thomas 1880: Fiji.

Rattus hawaiiensis Stone (1917) has been erected mainly on colour differences, but the individuals appear to be of a smaller general size though with larger skulls than the Samoan specimens. This form may not require specific rank, but is widely sccepted as differing from *R. exulans*. *R. micronesiensis* Tokuda (1933) is also a different form.

Most of the work on *R. exulans* has been done on preserved specimens and, though a large number of individuals have been examined, these form only very short series from any one locality. An attempt was made, therefore, while on a trip to Western Samoa, to collect as large a series as possible from one group of islands, to measure these rats in order to derive some statistics of the populations for later comparison with similar or larger series from elsewhere, especially with the New Zealand native rat, and to examine them for parasites. Also it was thought that colour variations would be more easily observed in fresh specimens.

Western Samoa is volcanic in origin and consists of two large islands, Savai'i and Upolu, with two small islets, Apolima and Manono, lying between the larger two, the whole group forming a line running roughly east and west. The capital of the territory is Apia on the northern shore of Upolu. Upolu was originally covered with tropical rainforest but now a wide belt of coconut, cocao, and banana plantations lies round the coast. Rats were collected on Upolu from Afiamalu on the edge of the rainforest, from plantations near Apia and on the prison farm at Tafagiata. The major part of the collecting was done on Manono which is covered with coconut plantations except for a small forest area on the northern face. This island is about 1 mile in diameter and rises to about 200 feet. It is within the reef bounding Upolu but some 3 miles offshore.

METHODS

The method of collecting was by trapping. The traps used were commercial breakback rat traps previously soaked in wax to prevent

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warping, fitted with a small stop allowing the trap to close only partially. Up to 35 traps were set at a time at 5 pace intervals shortly before dark. The trap line was brought in in the early morning and any specimens were placed in small cotton bags which were tightly tied so that ectoparasites could not escape.

In the examination both the rats and the insides of the bags were searched for ectoparasites and then external measurements were taken before the rats were skinned and sexed. Any skulls which were not too badly damaged were cleaned and preserved. The stomach and intestine was preserved in formalin for later examination for food and parasites.

The external measurements taken were:

Total length—measured between tip of nose and tip of tail excluding hairs when the rat was lying on its back along the ruler.

Tail—measured to tip when body was hanging at rt. angles to the ruler.

Ear—measured from top of skull to tip.

Foot c.u.—longest measurement from heel to claw.

Foot s.u.— longest measurement from heel to end of flesh.

Weight—measured in grams on a 250 gm. spring balance.

Skull measurements were taken with vernier callipers except for measurements of the auditory bulla which were taken with an ordinary ruler on a projected image of the skull.

Skull measurements taken were:

Total length—measured between parallels when skull was on a flat surface.

Condylo-basal l.—from rear of occipital condyle to front edge of incisor base.

Zygomatic breadth—across the greatest width, perpendicular to the long axis of the skull.

Interorbital breadth—across parallels giving least measurement.

Nasal—from back of suture to end of curved end.

Diastema—from tooth base to tooth base; least measurement.

Br. of rostrum—over incisor roots, perpendicular to long axis of skull.

Br. of braincase—behind zygomatic arch.

Depth of braincase—parallels giving least measurement.

Mandible—from articulation to end of bone on the inside.

Maxillary toothrow—from toothbase to toothbase.

Mandibular toothrow—from toothbase to toothbase.

The series of measurements was divided by locality—Manono and Upolu. The figures for each, and for the total series, were averaged and the standard deviations calculated. The Students t test was applied to the two series.

RESULTS

Food

Turbet (1925) states that *R. exulans* eats "growing coconut, pineapple . . . . . all stored food, copra, drapery."

Stokes (1917) mentions that *R. hawaiiensis* in captivity will eat snails and living arthropods. Thus it appears that *exulans* type rats will eat both animal and vegetable foods. On Manono, signs of rats eating small fallen coconuts and large broken coconuts were widespread. At one spot a large pile of snail shells was discovered, each damaged and chewed. They were possibly eaten by rats. Unfortunately none was collected or closely examined. One instance was seen of an *exulans* eating at a pineapple during the day, and the pineapple proved to have been almost completely hollowed out by rats.

The stomach contents of the rats caught were examined for parasites and for recognisable food debris. Of 29 examined 21 had some form of chitinous arthropod remains in them being identifiable in some instances as: ant (5); beetle (2); dipteran (2); spider (2); caterpillar (3), and centipede (1). Also, white vegetable debris was found in some.

Habitat

Rattus exulans is commonest in the thick undergrowth of soft plants standing about 2 feet high which grows in profusion in the coconut and banana plantations. The rats appear to be more common near to human settlements, but do not seem to be as dependent on man as the introduced *R. rattus* and *R. norvegicus*. These latter were rare on Manono, but both did exist, one *R. rattus* being caught and one *R. norvegicus* being seen. No evidence was seen of *exulans* climbing the coconut palms, but many small nuts lay around the trees and it has been suggested that rats are the cause of this fall of small nuts. However, we were told that in the Tokelau Islands, the rats do live in trees descending to forage.

Some rat holes were found but the main place of shelter seemed to be in piles of stones or walls.

Trapping carried out along the edge of the rainforest at Afiamalu produced only two rats which appeared to be *exulans* but were black in colour. Thus it seems that fewer rats inhabit the true rainforest at the higher cooler levels.

Pellage

The colour and texture of the fur of *concolor* type rats has been used in separating the different races. Rats collected in Samoa from the different areas were not identical in colouration but it is difficult to evaluate the worth of the variations.

Rattus exulans is generally: brown above, darker in the mid-dorsal line, and becoming paler down the sides. There is a fairly definite line of change to the yellowish-grey of the ventral surface. A tendency was noted for a yellower patch to occur at the front of the chest and for a yellow mid-ventral line to run backwards from this patch, fading into the basal colour. This line and patch were more obvious in the Manono series but were not confined to these rats.

The brown colour of the back runs on to the hand while the sides of the arm are paler

TABLE 1.
SKIN MEASUREMENTS OF *Rattus exulans*

MEASUREMENT	LOCALITY	NUMBER MEAS'D	AVERAGE	S	t	t PREDICTED FOR .01P	P	SIGNIFICANCE
Length.....	Samoa	42	259.3	15.8				
	Upolu	12	270.5	15.1	3.225	2.750	<.01	Significant
	Manono	30	254.8	13.9				
Tail.....	Samoa	42	136.4	8.1				
	Upolu	12	140.8	8.7	2.46	2.75	<.05	Probably significant
	Manono	30	134.3	7.2				
Ear.....	Samoa	41	15.4	1.1				
	Upolu	10	15.6	1.3	.501	2.75	>.05	None
	Manono	31	15.4	1.1				
Foot c. u.....	Samoa	44	26.4	1.1				
	Upolu	12	27.4	1.2	4.027	2.75	<.01	Significant
	Manono	32	26.1	0.9				
Foot s. u.....	Samoa	44	24.8	0.9				
	Upolu	12	25.7	0.9	4.676	2.75	<.01	Significant
	Manono	32	24.5	0.7				
Weight.....	Samoa	44	51	10				
	Upolu	12	56	10	.7	2.75	>.05	None
	Manono	32	49	9				

almost to the elbow in all specimens. On the foot darker colouring is visible along the outer edge. These characters are semi-diagnostic and, when combined with other characters, can be used to separate an *exulans* type rat from a young *R. rattus* or *R. norvegicus*.

The fur on the back and sides contains many spines but in the ventral fur there are fewer thinner spines.

Two black specimens were caught on the edge of the rainforest. As far as is known these are the first records of a black *R. exulans*, at least from Samoa. However, the measurements are not included.

Skin Measurements

Table 1 gives a summary of the measurements taken. Forty-four adults were examined in all, but through damage either in trapping or previously, certain individuals were excluded from some of the measurements.

It may be seen in the table that the figures for "length" and "foot" differ between Manono and Upolu with a probability in each case of less than 0.01 that this is a chance variation. The figures for length of tail have $P<0.05$ which is usually taken as the "probably significant" level of a statistical difference.

Thus there is a statistically significant difference between the populations on Upolu and Manono on the external measurements alone.

Skull Measurements

A summary of the skull measurements is given in Table 2. Because of the severe breakages caused by trapping with breakback traps only 31 skulls were worth preserving. Of these several were broken in some way and so the number of individuals measured for each dimension varies considerably. The braincase was the most damaged but loss of the auditory bullae was very common partly due to their falling out as the skull dried.

Five of the measurements: condylobasal length, zygomatic breadth, breadth of braincase, length of mandible, and length of bulla show a similar difference to the external measurements between the populations of Upolu and Manono each having a chance probability $P<0.01$. Four measurements differ with $P<0.05$ thus supporting the belief in a true difference. In all nine cases the rats of Manono give the smaller figure.

Parasites

Twenty-eight of the rats examined were infested with mites and three had lice in the fur. It is interesting that no fleas were found living on the Polynesian rat.

Gut parasites were almost universal; 75 per cent of the rats examined had nematodes living in the caecum and of these 15 or 38 per cent are listed as heavy infestations. Nematodes were also found commonly in the rectum and a few in the intestine. In the intestine cestodes occurred in over 50 per cent of the rats and in one two acanthocephalans were found. One cestode was found in the caecum. None of these parasites has as yet been identified further.

DISCUSSION

Though the series of measurements is not as long as might be desired, it has a value because of the limited areas from which the specimens were taken. The two areas are within one archipelago and were perhaps colonised by the rats at more or less the same time. Thus it is especially interesting that the results indicate differing populations in the two areas. The difference must be tentatively accepted for the combination of the statistical differences with the visual difference in pellage is more than suggestive, though whether it is phenotypic or genotypic is arguable.

Taking the measurements as a whole, it is possible to make comparisons with other published data. Tate (1935) divides the *R. exulans* types into six groups on general size and especially on the bulla and toothrow measurements. He gives Samoa a separate group but he only had a few specimens from Eastern Samoa for the basis of his conclusion. The

TABLE 2.

SKULL MEASUREMENTS OF *Rattus exulans*

MEASUREMENT	LOCALITY	NUMBER MEAS'D	AVERAGE	S	t	t PREDICTED FOR .01P	P	SIGNIFICANCE
Greatest length	Samoa	20	31.48	1.53				
	Upolu	6	32.70	0.79	2.71	2.878	<.05	Probably significant
	Manono	14	30.95	1.48				
Condylo-basal length	Samoa	21	29.21	1.46				
	Upolu	6	30.47	0.67	2.95	2.861	<.01	Significant
	Manono	15	28.70	1.39				
Zygomatic breadth	Samoa	23	14.9	0.46				
	Upolu	6	15.3	0.18	3.13	2.845	<.01	Significant
	Manono	17	14.7	0.43				
Interorbital breadth	Samoa	30	5.03	0.17				
	Upolu	6	5.05	0.11	0.376	2.787	>.05	None
	Manono	24	5.02	0.19				
Nasal	Samoa	28	11.56	0.62				
	Upolu	6	11.78	0.58	0.988	2.787	>.05	None
	Manono	22	11.50	0.62				
Diastema	Samoa	31	8.34	0.46				
	Upolu	6	8.72	0.29	2.443	2.75	<.05	Probably significant
	Manono	25	8.25	0.45				
Breadth rostrum	Samoa	30	5.32	0.31				
	Upolu	6	5.50	0.13	1.65	2.787	>.05	None
	Manono	24	5.27	0.32				
Breadth braincase	Samoa	22	13.25	0.29				
	Upolu	6	13.53	0.14	3.289	2.787	<.01	Significant
	Manono	16	13.15	0.27				
Depth braincase	Samoa	19	9.28	0.20				
	Upolu	6	9.28	0.10	0.059	2.898	>.05	None
	Manono	13	9.28	0.24				
Mandible	Samoa	31	17.55	0.79				
	Upolu	6	18.27	0.45	2.772	2.75	<.01	Significant
	Manono	25	17.37	0.75				
Maxillary toothrow	Samoa	31	5.32	0.26				
	Upolu	6	5.30	0.45	0.135	2.787	>.05	None
	Manono	25	5.32	0.29				
Mandibular toothrow	Samoa	31	5.03	0.17				
	Upolu	6	5.13	0.05	1.597	2.787	>.05	None
	Manono	25	5.01	0.18				
Width apart bullae	Samoa	17	2.46	0.20				
	Upolu	6	2.48	0.24	1.1038	2.947	>.05	None
	Manono	11	2.45	0.18				
Width between outer edges of meati	Samoa	17	12.87	0.45				
	Upolu	6	13.18	0.22	2.356	2.947	<.05	Probably significant
	Manono	11	12.70	0.46				
Width between inner edges of meati	Samoa	17	10.62	0.47				
	Upolu	6	10.94	0.30	2.292	2.947	<.05	Probably significant
	Manono	11	10.45	0.47				
Length bulla	Samoa	17	5.81	0.23				
	Upolu	6	6.00	0.18	3.075	2.947	<.01	Significant
	Manono	11	5.70	0.19				

measurements of his specimens appear to be larger than those taken on Upolu and Manono but of similar length in maxillary toothrow. The Samoan rats seem to lie somewhat on the small side of his total series.

While the rats on Manono appear to be smaller than those on Upolu, comparison with *R. hawaiiensis* measurements as given by Miller (1924) shows the different proportions of the Hawaiian rat which has a larger head in proportion to the size of the body. *Rattus maorium*, a synonym for *R. exulans*, is found in New Zealand and forms the southernmost example of the group. The type skull (Marples, 1954) is rather larger than the Samoan forms with a longer toothrow, and slightly different proportions.

R. exulans is distributed rather evenly over Polynesia, a fact which indicates distribution by man. It was already widespread before the coming of Europeans and *R. rattus* and *R. norvegicus*. Since the time of distribution there has probably been very little mixing, for ocean-going canoes do not appear to have persisted in their extreme form, and thus in fairly recent times many isolated populations of rats have been established. Variations in colour, size and proportions would be expected to arise among the constituent populations of such an assemblage finally giving rise to separable species. However, this has not yet occurred in the Pacific rats. The discovery of differing populations at two close areas, as at Manono and Upolu, show how complicated the picture may become, making general trends difficult to assess. The effect may be exaggerated in this case for Manono is a small islet lying three miles from the Upolu coast and within the reef and therefore only small canoes are used for transport. This may have had the effect of a wider geographical separation as the chance of introduction would be less.

The taxonomic position of the many populations of *exulans* type rats remains in doubt. Mayr tends to place bird populations across the Pacific in the same species. This could also be done with *R. exulans*, perhaps leaving the Hawaiian and Hebridean rats as subspecific forms. The geographical races occurring on each island are not sufficiently important for separate nomenclature. But it is possible that with long series to work from, factors useful for comparison of larger groups of rats may be found. The present series constitutes a starting point for this work.

SUMMARY

Specimens of *R. exulans* were collected in Western Samoa, 12 from the island of Upolu and 32 from the islet of Manono. Statistics of the populations are given and significant differences in several characters were found, though the islands are separated by only 3 miles of sea.

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